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立體微組裝技術在軟性電子產品上的發展與應用

The Development of 3D Micro-Assembly Technologies and Their Applications for Flexible Electronics

王可文

摘要

微組裝可以將微形元件依序安裝成具有特殊形狀的結構，它為不同尺度的微機電元件提供了新的製造與整合技術，近年來，微組裝技術的發展吸引了許多研究團隊的投入，但是，大部分的工作還是專注在利用液體表面張力，將單一元件與剛性基板結合在一起的二維組裝。這個研究計畫的目的在發展一套乾式組裝技術，它利用凡得瓦力將元件組裝到可撓的基板上。可撓的基板通常由有機聚合物構成，一般來說，它們與傳標準積體電路製程並不相容，因為傳統的積體電路製程包含許多高溫步驟。不過，由於軟性電子具有成本低與容易大面積製造的潛力，因此本計畫致力研發新的組裝技術，讓更多的元件可以與軟性電子產品整合。本計畫一共分三年三期進行，第一年的主要目標在瞭解元件與軟性基板在不同環境下、凡得瓦力的交互作用力，並建立一套相關的材料資料庫，並藉由初步的組裝測試，建立一套設計規範。第二年主要的目標在測試與了解組裝後，導電通道在不同頻率與不同環境下的導電特性，並研究元件與軟性基板結合後的散熱問題，並發

展最佳化的散熱方案。第三年的目標則在整合前兩年研發的經驗與成果，將三維乾式微組裝技術應用到大批量 LED 的組裝上，並以軟性電路為基板，組裝出實用性產品。

Abstract

Micro-assembly organizes micro-components into specific structures. It provides the basis for important new manufacturing techniques, especially for components at the cross scales. It has been demonstrated in recent years by several research groups. However, most of these works have been confined with a single type of component, on rigid substrate and to two-dimensional assemblies in aqueous environment. This project proposes a three-dimensional dry assembly plan on flexible substrate. Flexible substrates usually are chemically incompatible with conventional integrated circuit (IC) processing. In practice, the usual IC fabrication processes involve multiple-step high-temperature-processing that make flexible substrates have difficulty in adapting standard microfabrication techniques. However, flexible electronics has gained significant interest as a tunnel to low-cost or large-area electronics. This project will focue on the the development of 3D micro-assembly technologies and their applications for flexible electronics. The short-term goals (1 year) of this project include: to establish a material data base and design rules for the assembly process, which will result in assemblies that can be adjusted on demand. Near-term goals (2 years) include: to establish a process for the high-density microcircuit module interconnections. The interconnections should have good electric and thermal conductivities to reduce the bonding pad size of up-to-date microelectronic chips and flexible substrates, thus, it can lead to an increased interconnection density and a reduction in cost. Long goals (3 years) include: to demonstrate 3D micro-assembly in dry environment on flexible substrate with at least 2 different components; to include electronic and/or optical components in assembly, with essentially commercial components, and demonstrate a functional assembled device.